

CURRICULUM-VITAE

Dr. Avdhesh Chandra

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Education

- **Ph.D., High Energy Physics (1999-2006)**

Tata Institute of Fundamental Research (TIFR), Mumbai, India

Thesis: “Lifetime Difference in the B_s^0 System from Untagged $B_s^0 \rightarrow J/\psi\phi$ Decay at DØ”
Work performed on the DZERO experiment at Fermilab

- **Master of Science, Physics (1996–1998)**

Meerut University, Meerut, India

Appointments

- **Postdoctoral fellow (Nov 2009 – present)**

Rice University, Houston, Texas, USA

Stationed at Fermilab, and working on the DZERO & Mu2e experiments at Fermilab.

Employer: Dr. Marjorie D. Corcoran

Professor, Department of Physics and Astronomy,
MS-315, 6100 Main St, Houston, TX 77005

Phone: (713) 348-6078; E-mail: corcoran@rice.edu

- **Postdoctoral fellow (Sep 2009 – Oct 2009)**

Indiana University, Bloomington, USA

Stationed at Fermilab, and working on the DZERO experiment.

Employer: Dr. Richard J. Van Kooten

Professor and Chair, Department of Physics,
Swain Hall West 117, Indiana University, Bloomington, CA 92521, USA

Phone: (812)855-2650; Fax: (812) 855-0440 E-mail: rvankoot@indiana.edu

- **Postdoctoral fellow (Feb 2006 – Aug 2009)**

University of California, Riverside, California, USA

Stationed at Fermilab, and working on the DZERO experiment & CMS_LPC at Fermilab.

Employer: Dr. John Ellison

Professor and Vice Chair, Department of Physics and Astronomy,

University of California Riverside, CA 92521, USA

Phone: (951) 827-4301; Fax: (951) 827-3345 E-mail: john.ellison@ucr.edu

Invited Talks

- ***“Measurement of CP violation at $D\bar{D}$ ”***

Flavor Physics and CP Violation, Torino, Italy, 25-29 May, (2010)

- ***“B physics results from Tevatron, mixing and CP violation”***

Rencontres de Moriond EW 2009, LaThuile, Aosta Valley, Italy, 7-14 March, (2009)

- ***“CP violation results from $D\bar{D}$ ”***

ICHEP08, University of Pennsylvania, Philadelphia, USA, 1-5 Aug, (2008)

- ***“Search for new physics by measurement of B_s^0 Mixing parameters”***

Invited Talk, Tata Institute of Fundamental Research, Mumbai, India, 31 March, (2008)

- ***“Measurement of B_s^0 Mixing parameters from Flavor Tagged Decay $B_s^0 \rightarrow J/\psi\phi$ ”***

All $D\bar{D}$ Meeting (ADM), Fermi lab, USA, 25 Jan, (2008)

- ***“ B_s^0 Properties: Mixing, f_B , X_b , $\Delta\Gamma_s$ at $D\bar{D}$ and CDF”***

Lattice QCD Meets Experiment Workshop, Fermilab, USA, 11 Dec, (2007)

- ***“Lifetime Difference and Mixing in the B_s^0 System at $D\bar{D}$ ”***

Invited Talk, Argonne National Laboratory, Argonne, USA, 18 Oct, (2006)

- ***“Lifetime Difference and Mixing phase measurement at $D\bar{D}$ ”***

Beauty Conference, Oxford, UK, 28 Sep, (2006)

- ***“Lifetime Difference and Mixing phase in the B_s^0 System”***

$D\bar{D}$ Workshop, Fermi lab, USA, 17 Jul, (2006)

- ***“Measurement of the Lifetime Difference in the B_s^0 System at $D\bar{D}$ ”***

Poster presentation at New Perspective, Fermi lab, USA, 31 Mar, (2006)

- ***“Measurement of the Lifetime Difference in the B_s^0 System”***

Poster presentation at HCP06, Duke University, Durham, USA, 22 May, (2006)

- ***“Comparison of $B_s^0 \rightarrow J/\psi\phi$ lifetimes, average and CP separated”***
DØ B Physics Mini-Workshop, Indiana University, USA, 3-4 Dec, (2004)
- ***“Lifetime Difference in the B_s^0 System”***
Summer Physics Workshop, Fermi lab, USA, 28-30 Jul, (2004)
- ***“Study of $B_s^0 \rightarrow J/\psi\phi$ decays”***
XVI DAE-BRNS HEP Symposium, Saha Institute, Kolkata, India, 3 Dec, (2004)
- ***“Beam width measurement at DØ”***
XV DAE-BRNS HEP Symposium, University of Jammu, India, 11-15 Nov, (2002)
- ***“More than 30 presentations in DØ B Physics Group meetings”***
- ***“More than 10 presentations at DØ Luminosity Task Force meetings”***
- ***“More than 10 presentations at CMS simulation meetings”***
- ***“Several presentations at Muon ID, SMT & tracker meetings”***

Schools Attended

- ***“The Hadron Collider Physics Summer Schools”***
Fermilab, Batavia, IL, USA, 9-18 Aug, (2006)
- ***“10th ICFA School on Instrumentation in Elementary Particle Physics”***
Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil, 8-20 Dec, (2003)
- ***“International School on CP violation and heavy quark physics”***
Prerow, Germany, 21-27 Sep, (2003)

Publications

- **Collaborative Papers (2004-present)**

After fulfilling all the authorship requirements in 2004, I was added to the DØ author list of its physics publications. I have published more than 100 papers till date. All these papers are published in international refereed journals. For a complete list please see,

http://www-d0.fnal.gov/www_buffer/pub/Run2_publications.html#PUBLISHED

- **Primary Authored Papers**

(Inclusive in the collaborative paper list)

- ***“Measurement of B_s^0 Mixing Parameters from Flavor Tagged Decay $B_s^0 \rightarrow J/\psi\phi$ ”***
V. M. Abazov et al., **Phys. Rev. Lett** 101, 241801 (2008)
- ***“Combined $D\bar{D}$ Measurements Constraining the CP-Violating Phase and Width Difference in the B_s System”***
V. M. Abazov et al., **Phys. Rev. D** 76, 057101 (2007)
- ***“Lifetime difference and CP-violating phase in the B_s system”***
V. M. Abazov et al., **Phys. Rev. Lett** 98, 121801 (2007)
- ***“Measurement of the Lifetime Difference in the B_s^0 System”***
V. M. Abazov et al., **Phys. Rev. Lett** 95, 171801 (2005)

- **DZERO Internal Notes**

I have written many research papers and published in what is called “DØNotes”. DØNotes are considered an archive for DZERO collaborators, so these papers are considered to have much the same status as published papers:

- ***“Measurement of B_s^0 Mixing Parameters from Flavor Tagged Decay $B_s^0 \rightarrow J/\psi\phi$ ”***
DØ note 5488
- ***“Combination of $D\bar{D}$ results on CP violation phase in the B_s System”***
DØ Conf. note 5189
- ***“Lifetime Difference and CP Mixing angle in the B_s System”***
DØ note 5497
- ***“Lifetime Difference and Mixing Phase in the B_s System”***
DØ Conference note 5144
- ***“Lifetime Difference in the B_s System”***
DØ note 4810
- ***“Measurement of the Lifetime Difference in the B_s System”***
DØ note 4557
- ***“Same side tagging for use in B physics analysis”***
DØ note 4752
- ***“Beam Width measurement at DØ”***
DØ note 4753

• Media Publications

- “*New mixing in the standard recipe?*” Fermilab Results of the week, Feb 28, (2008)
http://www.fnal.gov/pub/today/archive_2008/today08-02-28.html
- “*Why antimatter does not matter?*” Fermilab Results of the week, Sep 14, (2006)
http://www.fnal.gov/pub/today/archive_2006/today06-09-14.html
- “*The Heavy Twin Appears to Live Longer?*” Fermilab Results of the week, Jul 21, (2005)
http://www.fnal.gov/pub/today/archive_2005/today05-07-21.html
- “*DZero Tracks Luminosity Spot*”, Fermilab Results of the week, Jul 22, (2004)
http://www.fnal.gov/pub/today/archive_2004/today04-07-22.html

Research Experience

• 1999-2001

After joining TIFR, I did an experimental project on a Proportional Counter. We made prototype single wire Proportional Counter and studied characteristics of the Proportional Counter (gas gain) with respect to applied voltage, pressure and different gas mixture. Results and report of the work was submitted to TIFR graduate school.

After completing all the necessary courses, in 2000, I joined Department of High Energy Physics TIFR, collaboration with DØ experiment at Fermilab. During my first year of joining the group, I did one project on organic scintillator (made of poly vinyl tuolene), PMT and wave guide. The aim was to learn how to prepare the system for use as a triggering and counting device. I also did one simulation project on “ $p \bar{p} \rightarrow b \bar{b}$ ” simulation studies at Tevatron Energy $\sqrt{s} = 1.96 \text{ TeV}$ ” under DØ RunII framework.

• 2001-2006

As a graduate student of Tata Institute of Fundamental Research (TIFR) and as a member of DØ collaboration at Fermilab USA, my major contributions to the DØ experiment are listed below:

Measurement of the Lifetime Difference in the B_s^0 System The decay $B_s^0 \rightarrow J/\psi\phi$, proceeding through the quark process $b \rightarrow c \bar{c}s$, gives rise to both CP-even and CP-odd final states. It is possible to separate the two CP components of the decay $B_s^0 \rightarrow J/\psi\phi$, and thus to measure the lifetime difference, though a study of the time-dependent angular distribution of the decay products of the J/ψ and ϕ mesons. For my Ph.D. thesis, I worked for measurement of lifetime of CP-even and CP-odd eigenstates for untagged $B_s^0 \rightarrow J/\psi\phi$ decay. As CP violating phase in the $B_s^0 - \bar{B}_s^0$ mixing, ϕ_s , is predicted to be small in SM, to a good approximation, the two mass eigenstates (B_s^L and B_s^H) are expected to be CP eigenstates. We measured the decay amplitude of CP-even and CP-odd eigenstates for B_s angular analysis. We perform an unbinned maximum likelihood fit to the RunII data, including the B_s candidate mass, lifetime, and the transversity angle in the decay. (In the following, we use the shorthand “transversity” for the cosine of the transversity angle.) We extract three parameters characterizing the B_s system and its decay $B_s^0 \rightarrow J/\psi\phi$: $\tau = 1/\bar{\Gamma}$ (where $1/\bar{\Gamma} \equiv (1/\bar{\Gamma}_H + 1/\bar{\Gamma}_L)/2$, $\Delta\Gamma/\bar{\Gamma}$, and the relative rate of the decay to the CP-odd states at time zero. It was one of the most important measurements in the Run II B physics program. This result was published in PRL (hep-ex/0507084, Phys. Rev. Lett. 95, 171801, 2005).

Same side tagging for use in B physics analysis I developed the Same Side Tagging (SST) algorithm for DØ to use in studies of CP asymmetry in B decays. The Same Side Tagging (SST) method utilizes correlations between the b -quark flavor and the charge of associated particles from the hadronization process to tag the production flavor of B mesons. We exploit this flavor-charge correlation by selecting a π^\pm near the B meson as a tag. Several methods for selecting the tag track in the vicinity of the B meson have been studied. Different tag track selections will be preferred depending on the analysis application, e.g. partially reconstructed B decays versus fully reconstructed decays or semileptonic versus hadronic modes. For this work, I got help from James Fast (Fermilab), and now this work is integral part of official “*bflavor_tag*” package, used for tagging B decays at DØ.

• 2006-present

Since February 2006, as postdoctoral fellow of University of California Riverside, I worked as a member of DØ collaboration at Fermilab and CMS collaboration at CERN. My contributions to the DØ experiment are many physics analysis and several major/minor services works. Some of the major contributions are listed below:

Measurement of B_s^0 mixing parameters from flavor tagged decay I am working on measurement of CP-violating phase and lifetime difference of B_s^0 mass eigenstates, from flavor tagged $B_s^0 \rightarrow J/\psi\phi$ decay. In the Standard Model (SM), the light (L) and heavy (H) mass eigenstates of the mixed B_s^0 system are expected to have sizeable mass and decay width differences: $\Delta M_s \equiv M_H - M_L$ and $\Delta \Gamma_s \equiv \Gamma_L - \Gamma_H$. The CP violating phase, ϕ_s , defined as the relative phase of the off-diagonal elements of the mass and decay matrices in the flavor ($B_s^0 - \bar{B}_s^0$) eigenstates. The ϕ_s is predicted to be small and can be represented as $\phi_s = 2\arg[-V_{tb}V_{ts}^*/V_{cb}V_{cs}^*]$, where V_{ij} are elements of the Cabibbo-Kobayashi-Maskawa (CKM) quark-mixing matrix. ΔM_s is now measured with good accuracy, but for any new physics contribution, measurement of CP-violating phase is necessary. We reported the first direct measurement of CP violation phase from untagged analysis, published in PRL (hep-ex/0701012, Phys. Rev. Lett. 98, 121801, 2007). The untagged analysis measurement suffered from four-fold ambiguity which is resolved by the current work and "Measurement of B_s^0 mixing parameters from flavor tagged decay" was published in PRL (arXiv:0802.2255[hep-ex], Phys. Rev. Lett. 101,241801, 2008). The CP-violating phase ϕ_s was extracted for the first time in this analysis. Improved precision was obtained by refitting the results using additional experimental constraints. Adding the information on B_s^0 flavor at production time resolves the sign ambiguity on ϕ_s for a given $\Delta \Gamma_s$ and improves the precision of the measurement.

The current ϕ_s measurement from DØ is approximately 2- σ away from SM, more data is required if this deviation is real. The ϕ_s measurement from CDF experiment is also away from the SM in the same region of $(\Delta \Gamma_s, \phi_s)$ plane. It calls for an extensive study of ϕ_s measurement and revise each step of the analysis to see for any improvement can be made. For the next analysis we are

considering for the improvements in the selection criteria using likelihood ratio and/or neural network technique. As kinematics parameters are used to extract angular distribution of $B_s^0 \rightarrow J/\psi \phi$, so it is very important to make sure that there is no bias when doing B_s^0 particle selection. To enhance the statistics, we are also studying the possibility of J/ψ reconstruction from its decay to e^+e^- , which is rather difficult due to huge noise.

Beam Width Study I developed tools for determining the beam width at the DØ interaction point using impact parameter correlation method. During this period I got crucial help from Juan Estrada (Fermilab) at various stages. The beam width analysis was found to be very helpful for the Fermilab Beams Division to monitor the performance of the accelerator complex. Initially, observations indicated that the beam width (related to the amplitude function β^* , and hence to luminosity) was significantly larger than the DØ design value of 35 cm, indicating likely problems with the beam-focusing magnets. The measurements were discussed with accelerator experts, and finally in May 2004, change in low beta quads produced a 20% increase in luminosity at DØ since then! Now measurement of β^* shows that its value is near to DØ design value. *This work was featured in Fermilab Today (July 22, 2004), with the headline ``DZero Tracks Luminosity Spot''.* We are considering developing tools and procedures to measure beam-width at DØ for regular shifters to monitor the performance of the accelerator complex in every store. I have given responsibility for monitoring the beam width at DØ interaction point since last six years.

Work on SMT Silicon micro strip tracker (SMT) is the nearest tracker to the beam pipe, so it's very important to keep an eye on radiation damage on silicon detector. We also have to observe the change in properties of silicon detector with radiation does it gets with time. While operating, silicon detectors require sufficient bias voltage to fully deplete the entire silicon volume. The depletion voltage changes with the radiation dose received by the detectors. I worked on bias voltage scan method to determine the depletion voltage for the detectors. Depletion voltage is then used as a function of radius and time, in determination of silicon tracker lifetime. I have

developed the software, and measured the depletion voltage. The software and results are given to the task force for further study due to shortage of time. Knowing SMT detector better, I am also doing SMT shifts in the control room.

- **2008-2009**

The LHC physics center (LPC) CMS group at Fermilab: Since end of year 2007, I also joined LPC-CMS group at Fermilab to work on CMS experiment at CERN Geneva:

Tracking Studies with Fast Simulation I am working with fast simulation group on validation, performance and benchmark for CMS detector and upgraded tracker. Development of fast simulation tools is important with complex and time consuming full simulation; it will become crucial for many studies as full simulation will be very slow with upgrade & pile-up I am working with Prof. John Ellison for this work. *While developing the benchmark plots we have identified and corrected a very important error in treatment of stable particles, which was causing a low efficiency in validation plots.* We are working on the efficiency and fake rate study of the tracker for different purposed geometry, called ``strawmanA" & ``strawmanB". StrawmanA, is the perturbation of the current CMS tracking system with 4 inner pixel layer, 2 strixel plus 2 short strip in the inner layer (TIB) and 2 strixel plus 4 short strips in the outer layer (TOB). While StrawmanB %is design radically different from the current CMS tracker, it contains super layers each with two doublet layers and three inner pixel layers. We have compared various performance plots between standard current geometry and the purposed geometries. Now we are studying them with higher luminosity environment expected at SLHC. At present we are developing a tool for tracking jets that will be used for study b-tagging and other jet physics process.

- **2009-present**

Mu2e group at Fermilab: I continued my postdoctoral fellow job with Rice University, Houston. Since November 2009, with my responsibilities of D0 experiments, I joined Mu2e experiment at Fermilab:

Detector Simulation The muon-to-electron conversion experiment (Mu2e) is designed to search for the coherent, neutrino-less conversion of a muon to an electron, in the Coulomb field of a nucleus. This process is heavily suppressed in standard model (SM), any signal observed will be unambiguous evidence of a new physical process beyond SM. I am working with simulation group and contributing to mu2e simulation efforts with Geant4. Geant4 is a standard tool used for most of the simulations of collider and fixed target experiments and particle detector in HEP. Mu2e experiment has three major parts, production solenoid, detector solenoid & transport solenoid. Transport solenoid connects detector solenoid and production solenoid and is an important part of the mu2e experiment which is primarily used for transporting muons to detector solenoid with removal of all other particles produced in the production solenoid. I have written code for simulation of “Transport Solenoid” which was missing in the current version of mu2e simulation code. I have also written code for “Proton Absorber”, which sits inside detector solenoid to absorb secondary protons.

I am also working for the simulation of multiple scattering in FastSim, which eventually will be used to compare with full simulation (Geant4). Multiple scattering is not well understood in the full simulation around mu2e working energy range.